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LATERAL ASYMMETRY IN PATTERN RECOGNITION: UNDERSTANDING THE EFFECTS OF FAMILIARITY, DISTINCTION, AND PERSPECTIVE CHANGE

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

CHARLES BATES, JR.
Director, Human Engineering Division
Armstrong Aerospace Medical Research Laboratory

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The effects of perspective change and familiarity upon lateral asymmetry for a face recognition task are analyzed based on the results of several experiments. A four choice match-to-sample procedure involved frontal target perspective faces and choice sets which contained faces in either front perspective, 3/4 perspective, or side perspective faces. The study assesses the effects of stimulus familiarity and distinctiveness. Results taken from analysis of variance, multidimensional scaling, and hierarchical cluster analysis suggests complex relationships between the sensitivity of faces and the ensuing development of familiarity. Conclusions are drawn in terms of implications for interpreting higher order cognition in laterality studies. Keywords !

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Preface

The research for this report was performed by the Harry G. Armstrong Aerospace Medical Research Laboratory, Human Engineering Division, Wright-Patterson AFB, Ohio in support of Work Unit 71841046, Strategic Information and Force Management.

The support of the following Systems Research Laboratory personnel was essential in conducting the research. Bill McGovern who served as experimenter; Curt Mayrand and Brian Porter for their adept programming skills and advice; and Greg Bothe who provided timely insights and oversaw the engineering/hardware development.

I would also like to thank Mr. Walt Summers, Lt. Col. William Marshak, and Mr. Don Monk, AAMRL/HE, for their support of this research

Dr. Katsuyama participated in this research while he was in residence at the Armstrong Aerospace Medical Research Laboratory as a National Research Council Associate appointee.

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INTRODUCTION

Recent models of face recognition have proposed the use of different processing mechanisms, each of which are utilized according to the demands of the task, the nature of the stimuli, or the temporal stage of processing (e.g Ellis, 1983; Klatzky, 1986; and Rhoades, 1985). The different subprocesses proposed in any of these models could conceivably involve left- or right-hemisphere (LH or RH) lateralization. Accordingly, the nature of lateral asymmetry (visual fields effects) in face recognition obtained from different experiments might result from the use of different types of processing mechanisms. Hence, results that have previously appeared contradictory might be attributable to differences in procedural or stimulus differences which, in turn, elicit different processing strategies. For example, although procedures that require recognition of unfamiliar faces tend to generate greater left visual field (LVF/RH) superiority, nevertheless, procedures involving familiar faces tend to produce RVF/LH superiority (e.g.,; Marzi & Berlucchi, 1977, Tressoldi, Barry, & Tassinari, 1986; Umilta, Brizzolara, Tabossi, & Fairweather, 1978). Satisfactory performance in conditions involving highly familiar stimuli could require minimal processing of only a single, salient feature. In contrast, recognition of unfamiliar faces might require a deeper level of processing in which several features need to be evaluated. This distinction might be characterized in terms of Cohen's (1973) description of serial (or piecemeal) versus parallel (or configurational) processing. Accordingly, the LH would be expected to excel in the extraction of a single feature difference while the RH would excel in the synthesis of individual features.

In several studies, the role of stimulus familiarity was manipulated by means of repeated exposures during experimental trials. Kossak and Turkewitz (1986), Reynolds and Jeeves (1978), Ross and Turkewitz (1982), and Ross-Kossak and Turkewitz (1984), utilizing a small set of faces, demonstrated declines in initial LVF advantages followed by subsequent increases. These results could be interpreted in terms of processing strategies. Initial processing might involve evaluation of a configuration of features (perhaps similar to a gestalt) leading to a LVF advantage. Subsequently, as familiarity accrues, subjects engage in criterion shifting, responding according to a piecemeal mode of representation. Hence, due to the utilization of a single, distinctive feature, a RVF advantage is demonstrated during this stage. With further familiarity, subjects shift to a strategy involving the synthesis of individual features into a prototype that results in a reemergence of the LVF advantage. Findings such as these necessitate the use of a multi-process model of complex pattern recognition that involves both hemispheres.

A series of studies conducted at the Armstrong Aerospace Medical Research Laboratory, have investigated the role of familiarity upon visual field effects (see Katsuyama and McNeese, 1987, 1989; Katsuyama, McNeese, and Schertler, 1987; and McNeese and Katsuyama, 1987). The initial two studies examined familiarity by comparing visual field effects across each of four trial blocks. Changes in visual field effects associated with increased exposure to facial stimuli with each successive trial block could represent differential employment of cognitive processing strategies elicited by more familiar stimuli. Thus, familiarity might cause changes in knowledge representation, whereupon certain strategies rely upon different representations under familiar and unfamiliar situations. Furthermore, a second session was administered to examine the effects of additional exposure to the same facial stimuli. The study reported here manipulated familiarity by exposing half the subjects to a condition which contained only one set of faces, and another group of subjects to a condition which contained two sets of faces. Thereby, the first condition receives greater exposure to each face in the experiment than does the second condition, hence leading to greater familiarity with the faces in the first condition.

One of the issues involving familiarity is the extent to which each face within the set of experimental stimuli might become familiarized differently based upon the saliency of specific features. Some faces may contain dominant, distinctive, or easily "picked-up" features (e.g., a large nose) which allows them to be familiarized with a much faster criterion. This could lead to greater reliance on a LH strategy for such face types. On the other hand, other faces may be less distinctive and may require additional processing before familiarity ensues. These face types may require much more involvement by the RH. In order to assess the effects of such individual differences in the nature of the stimuli used, Multi-Dimensional Scaling (MDS) and Hierarchical Clustering Analysis approaches were utilized to see if the individual differences of stimulus items used might be predicated upon underlying dimensions. This is related back to looking at the demands inherent in the nature of stimuli used and may be entirely responsible for contradictory results that tend to occur in the laterality literature.

Because different faces may be paired randomly as target and choice items (under certain restrictions), familiarity may be skewed in terms of its development across experimental trials. Any given trial might contain a predominance of highly distinctive, less distinctive, or both face types. If such differences exist in the stimuli themselves, and they are not attended to during construction of trial types, then is it possible that laterality effects might be contingent -in part- to the luck of the draw? Different experiments may show different laterality results due to subtle interactions between individual differences in the familiarization of stimuli and individual differences/subject across conditions. Thus, the goals of the MDS and HCA approaches are to explore whether subjects react to pairings of the target stimulus face and the response choice face by constructing a confusion matrix of possible choices between faces.[1] Results of these analyses should demonstrate whether subjects made confusions consistently across pairs or whether some underlying dimension acted to cluster faces differentially. This would tend to indicate that different pairings facilitate different salience hierarchies, and thus differential sensitivity to familiarity development which determines the nature of laterality direction.

1. Please note that these analyses were performed on a subset of the subjects taken from one of a series of four experiments. All four experiments used the same stimulus materials (i.e., the same model's faces were used). Each experiment manipulated familiarity in a different way. This paper will focus on experiment number III, but the results can be applied to all the studies as they use the same faces. More subjects' data could be analyzed if their data tapes could be obtained. However, the ten subjects represent a total of 2,880 trials of data and more than twenty hours of data collection. One should note too that most subjects across all experiments conducted perform at an overall consistent performance rate of about "58% correct responses". Yet, looking within individual conditions per subject (and comparing them with other subjects), there are many individual differences, especially in laterality. These differences seem to cause paradoxical results across studies. One of the major reasons that precipitated further analysis is to see if there are distinctions in the stimuli themselves that could contribute to such results.

In addition to investigating the role of familiarity and distinctiveness upon lateral asymmetry in face recognition, these studies examined differences between recognition based upon physical features and "structural" features (e.g., higher-order relations and perceptual invariants across perspectives). All the studies utilized a four choice, match-to-sample procedure; whereby, a frontal perspective target face was laterally presented on each trial, followed by a set of four choice faces all of which were presented either to the front (F), 3/4, or side (S) perspective. On trials involving type F choice faces, the correct choice was physically identical to the target face. Hence, either piecemeal or configurational encoding would permit reliable recognition performance which equates to expecting minimal visual field effects. In contrast to type F choice sets, type 3/4 and type S choices should contain fewer specific features (e.g. eyes, nose, mouth, hairline, etc.) common to that contained within the corresponding frontal target face. Hence, common configurations or higher-order relations should provide a more reliable basis for identifying the target face on these trials. If configurational encoding of multiple features or higher-order relations is better accomplished by the RH, then larger LVF/RH advantages would be expected on type3/4 and type S trials than on type F trials.

METHOD

Design

This experiment utilized a 2 (Visual Field) X 3 (Perspective of Choice) X 4 (Trial Block) balanced factorial design.

Subjects

Subjects were 48 male college students, 32 of whom participated for credit toward an Introductory Psychology class and 16 of whom were paid. All had 20/20 vision, with or without correction.

Apparatus and Stimulus Materials

A "Thunderscan" digitizer was used to prepare stimuli for display on a 512K Macintosh microcomputer system equipped with a 20 megabyte hard drive and a 22.9 cm. (9 in. diagonal) black and white monitor. Responses and reaction times were recorded by means of a four-button keypad connected to a Commodore 64 microcomputer. Audio response feedback was delivered by the Commodore 64 through a portable Radio Shack amplifier/speaker.

Experimental stimuli were prepared from black and white photographs taken of 12 male and 12 female adult models. Each model was photographed from a F, 3/4, and S perspective. Photographs of eight additional models were used to construct practice stimuli. All photographs depicted a neutral expression without glasses, beards or mustaches, or salient nonfacial features. Contact prints of the above photographs were digitized, adjusted to form 2.1 x 2.6 cm. graphic images, bit-mapped, and stored on disk. The entire set of experimental stimuli were divided into two equal-sized sets (A and B). Each set depicted 12 male and 12 female individuals.

A series of 12 practice trials and 288 experimental trials were constructed. Each trial consisted of a standard containing a target face and a choice set of four faces. A 3mm. x 3mm. white cross was centered on each of these fields. The edge of each target face was located 3.3. cm.

(2.1 degrees viewing angle) left or right of center. The four faces within a choice set represented the same perspective. Each depicted a different model and was randomly located in one of the four quadrants.

A single order of 144 trials was generated for each set with the following constraints: a given model appeared as a target stimulus on six trials, once for each of the six Visual Field X Perspective combinations. Furthermore, each model appeared once or twice in each of four blocks of 36 trials. Also within each block of 36 trials, Visual Field (of the target), Gender (of the target model), and perspective were counterbalanced. Finally, each model appeared as a foil on a total of 18 trials.

Procedure

Subjects were individually administered 12 practice and 288 experimental trials in a semi-darkened room. Subjects were seated in front of a chin rest located at a distance of 92 cm. from the display screen. Prior to each trial the screen contained only the white fixation cross against a black background. Subjects initiated each trial by pressing the computer's space bar. The standard field appeared for 133 ms., followed by a 1/2 s. gray masking field and a 1/2 s. blank screen. The choice set was, then, presented for 5 s. followed by a 133 ms gray masking field.

Subjects were instructed to select the choice face that depicted the same model as did the standard and to respond by pressing the keypad button in the same relative location. Set A or Set B stimuli were presented in each of two series of 144 trials. For one-half the subjects (Condition 1), a single set (A or B) was used throughout the entire session (trials 1- 288). For the remaining subjects (Condition 2), both Sets A and B were used, one during trials 1 - 144 and the other during trials 145 - 288. In Condition 1, one-half of the subjects received Set A stimuli throughout the session, while the remaining subjects received Set B. In Condition 2, one-half the subjects received Set A during trials 1 - 144 and Set B during trials 145 - 288. For the remaining subjects, the order in which the sets were used was reversed. Within each Condition X Initial Set combination, trials were administered in forward order for one-half the subjects and reverse order for the remaining subjects.

All subjects made right-handed keypress responses to indicate their selection of choice stimuli. Auditory feedback was provided immediately following each response. (A correct response was indicated by a high tone while an incorrect response was indicated by a low tone). Responses and reaction times were automatically stored by the Commodore 64 microcomputer.

The entire series of experimental trials was composed of four blocks of 72 trials each. The visual field of the target was counterbalanced with the perspective of the choice set within each block of 72 trials. Across the entire series of trials, each model occurred six times as a target stimulus (once in each of the six possible combinations of visual field and perspective) and between 16 and 19 times as a choice item. Within these constraints a single order of target/choice set trials was randomly predetermined.

Selection of Proximity Matrix for MDS and HCA

The creation of the proximity matrix was based upon several data transformations of a randomly selected subset of the original subject pool data (i.e., for 10 subjects). In order to eliminate the obvious dimension of gender as an underlying difference, the matrix used only confusions involving female faces. The creation of a proximity matrix based on stimulus confusions is similar to ideas expressed by Shephard (1974) and takes the specific form of a stimulus-response confusability, although note that in this experiment a face may be a stimulus or a response choice dependent on each particular trial.

Specifically, the matrix constructed here is based on the proportion of times subjects respond face " X" when stimulus " Y " was presented. A transformation of these confusability values into proximity values occurred by subtracting them from 1. Thus, the resulting matrix is similar in form to that provided by Rothkopf (1957) for similarities among Morse Code Symbols based on their respective confusions.

Because the extensive counterbalancing in this experiment (sets, conditions, gender, visual field, order, and perspective), created different proportions of face availability across trials, it was necessary to devise a computer program to access the data tape and perform the necessary transformations and equalization across trials to derive confusability pairings for each possible combination of facial stimuli. Please note also that the variables, Visual Field and Perspective Change were collapsed across subjects in order to provide enough observations per cell for all of the face combinations. The number of confusions divided by the number of possible appearances of a stimulus equated to a percentage of confusions present for all combinations of the twelve faces. The computer program provided each subject's confusion matrix. These values are summed across subjects to produce the overall confusion matrix (see Appendix A) and then each cell is subtracted from 1 to provide a proximity measure. Please note that there was one missing value in this matrix. In accordance with Kruskal and Wish (1978) an average value was taken from all other entries in the matrix and placed in this cell as an entry. The final matrix transformation is then used for both the MDS and the HCA programs, respectfully.

The half matrix used is assumed to be roughly symmetric although some variations can exist in terms of whether a face is a target or a choice. In order to remedy this the proportions of each half-matrix are averaged. Where missing data existed in one half-matrix it may be obtained by looking at the other half-matrix and using the respective value, if present. As indicated, only one cell lacked data by using this technique of averaging with selective replacement. This method helped to derive a more symmetric half matrix.

MDS Parameters

The half matrix described above may be submitted for analysis. Two runs of data must be considered. First, an MDS test using nonmetric scaling is run. Finally, the MDS is run using metric scaling. Initial thoughts are that the data will respond more positively to the metric scaling due to the way the cells were constructed from stimulus-response confusions. However, to be comprehensive and observe each set of results the nonmetric scaling is important also. Furthermore, the extent of differences in terms of the number of dimensions derived for each run may be an important consideration.

HCA Parameters

The HCA partitioning method is the major issue of determination. In consideration of the suggestions in Aldenderfer and Blashfield (1984), the single and complete linkage methods seem to capture some of the advantages that exist at each end of the continuum in the linkage methods. Each of these method's results must be compared and interpreted to see if different clustering solutions are formed. The one which matches intuitive, substantive considerations is chosen as being the most informative.

RESULTS

Correct Recognition Responses

Trials 1-144 (trial blocks 1-4). A separate 2 (Number of Stimulus Sets) X 4 (Trial Block; 36 trials /block) X 2 (Visual Field) analysis of variance was performed upon correct recognition responses for each type of perspective, type F, type 3/4, type side. As expected, neither the main effect of the Number of Stimulus Sets nor any interaction involving that factor was significant. Note that all subjects received the same set of faces as stimuli in trials 1 - 144.

In the analysis of correct frontal responses, there were slightly more correct responses following RVF than LVF presentations ($\underline{M}$s = 18.50 and 17.83), but this result did not attain significance, $\underline{F}(1,46) = 3.48$, $\underline{p} = .07$. However, the Block X Visual Field interaction was significant, $\underline{F}(3,138) = 6.65$, $\underline{p} < .001$, reflecting the RVF advantage on blocks 1 and 4 but not on blocks 2 and 3.

The results for type 3/4 trials appeared to be quite different from those for type F trials. As expected improvement occurred across trial block, $\underline{F}(3,138) = 5.78$, $\underline{p} < .001$. However, a Block X Visual Field interaction was obtained, $\underline{F}(3,138) = 3.23$, $\underline{p} < .05$, reflecting the emergence of a LVF advantage on block 4.

On type S trials there were no significant effects attributable to Visual Field. Performance remained similar across blocks 1 to 3 with improvement from block 3 to block 4, $\underline{F}(3,138) = 5.69$, $\underline{p} < .01$.

Trials 145-288 (trial blocks 5-8). As was done for the results from trials 1-144, separate 2 X 4 X 2 analyses of variance we performed upon correct recognition responses on trials 145-288 for each type of perspective.

In the analysis of type F responses, the main effect of Stimulus Condition approached significance, as subjects in Condition 1 (who received a single set of stimuli) tended to make more correct responses than those in Condition 2 (who received both sets of stimuli), (Ms =

39.67 and 36.88, respectively), $F(1,46) = 3.93$, $p = .053$. The significant Trial Block X Visual Field interaction, $F(3,138) = 4.25$, $p < .01$, reflected the finding that a RVF advantage occurred on blocks 5 and 8, while a LVF advantage occurred on block 6.

There was a trend toward a greater number of correct type 3/4 responses among subjects in Condition 1 ($M = 33.50$) than in Condition 2 ($M = 30.46$), $F(1,46) = 3.97$, $p = .052$. Performance improved after trial block 6 (Ms = 3.83, 3.82, 4.08, 4.25 for blocks 5-8), $F(3,138) = 3.04$, $p < .05$. Finally, the significant Block X Visual Field interaction, $F(3,138) = 2.70$, $p < .05$, was the result of LVF advantage on blocks 5 and 8 and a RVF advantage on blocks 6 and 7.

On type S trials, subjects in Condition 1 made more correct responses ($M = 29.21$) than those in Condition 2 ($M = 25.92$), $F(1,46) = 6.55$, $p < .05$. A significant Block X Visual Field interaction reflected the finding that a RVF advantage occurred only on blocks 6 and 7. (On block 8 the Visual Field effects appeared to differ according to Stimulus Condition. There was a slight RVF advantage among subjects in Condition 1 (Ms = 3.79 and 4.08) and a slight LVF advantage among subjects in Condition 2 (Ms = 3.50 and 3.12). However, in an analysis of block 8 performance alone, the Condition X Visual Field interaction was not significant, $F(1,46) = 2.07$, $p = .16$)

Mean Response Times

Trials 1-144 (blocks 1-4). As was done for the analysis of correct responses, separate 2 (Number of Stimulus Sets) X 4 (Trial Block) X 2 (Visual Field) analyses of variance were performed upon each category of Perspective, type F, 3/4, and S. As expected, the Number of Stimulus Sets was not significant, nor did it interact with any of the other factors. In each analysis, only the main effects of Trial Block and Visual Field were significant.

On type F trials, response times declined across blocks (Ms = 2.00 s., 1.83 s., 1.77 s., 1.73 s.), $F(3,138) = 12.80$, $p < .001$. In addition, response times were faster following RVF than LVF target presentations (Ms = 1.81 s and 1.86 s), $F(1,46) = 4.45$, $p < .05$.

Response times on type 3/4 trials also declined across blocks ($\underline{M}$s = 2.37 s., 2.22 s., 2.18 s., 2.07 s.), $\underline{F}(3,138) = 8.48$, $\underline{p} < .001$. However, response times were faster following LVF target presentations ($\underline{M}$ = 2.17 s.) than RVF target presentations ($\underline{M}$ = 2.24 s.), $\underline{F}(1,46) = 4.56$, $\underline{p} < .05$.

Finally, response times on type S trials declined across blocks ($\underline{M}$s = 2.50 s., 2.44 s., 2.32 s., 2.30 s.), $\underline{F}(3,138) = 3.99$, $\underline{p} < .01$, and as was the case for type 3/4 trials, response times were faster following LVF than RVF presentations ($\underline{M}$s = 2.36 s. and 2.43 s.), $\underline{F}(1,46) = 4.63$, $\underline{p} < .05$.

Trials 145-288 (blocks 5-8). In the analysis of response times on blocks 5 to 8, the only significant finding was a decline in Type S response times on block 8 ($\underline{M}$s = 2.34 s., 2.35 s., 2.32 s., 2.16 s. for blocks 5 to 8, respectively), $\underline{F}(3,138) = 5.83$, $\underline{p} < .001$.

MDS Analysis

Multidimensional scaling. A version of Takane, Young, and De Leeuw's (1976) ALSCAL program performed MDS using the Euclidian metric and computing stress with Kruskal's Formula 1, for a run that utilized the ordinal measurement level and for a run that used the interval measurement.

Dimensionality. The ALSCAL program estimates a one-dimension, two-dimension, and three-dimension solution until the fit provides no significant improvement by adding additional dimensions. The stress measure provides a goodness of fit criterion that allows determination of dimensionality. For the ordinal run, examination of the stress values per number of dimensions reveals that the stress values are too high, for a three-dimensional solution, Stress = .289, RSQ = 426. For the interval run, examination of the stress values per number of dimensions reveals that the three-dimensional solution is appropriate as Stress = .180, RSQ = .601. Thus, the stress values, the RSQ, and the interpretability of the dimensional solutions together suggested that the three dimensional solution using interval measurement was most appropriate.

Interpretation of dimensions were judged based on previous knowledge of stimulus items as well as examination of the specific facial stimuli. Because gender was already eliminated this factor does not play into the solution. Based on these observations, and other substantive criteria from conducting these series of experiments an interpretation may center around the dimensions of: 1.) shape of the face (thin to broad), 2.) distinctiveness of hair parted in the middle, and 3.) age of subject. These are the dimensions upon which the subjects seemed to vary at an obvious level.

HCA Analysis

An examination of the single linkage solution suggests there are two clusters, when one plots the number of clusters against the fusion coefficient. There seems to be a natural break in the curve between coefficient .86 and .90 which specifies the 2 cluster solution as the best fit. Upon examination of the complete linkage method, the natural break seems to be more robust than with the single linkage, and occurs between coefficients .83 to .90, which suggests a 3 cluster solution. Based on this criterion of fit, as well as the assumptions behind the complete linkage solution, it was chosen as the appropriate method.

Due to the subjective nature of these faces, it is imperative to rely upon past research and substantive criteria to make judgments in appropriateness. In observing the faces that were put into each cluster, a tentative interpretation of the clusters is given. The analysis reveals three clusters within which there is a distinct salient dimension present. Cluster 1 consists of faces which have the salient dimension of "same mouth configuration." By comparison, Cluster 2 consists of faces which have the salient feature of "deep, inset eye geometry." In contrast, Cluster 3 consists of faces with the salient feature of "long and narrow-width nose configurations." Thus, this analysis has been sensitive to the individual features within a group of model faces that form a given cluster. It may be that these features form the basis for different prototypes, that act to categorize stimuli based on these characteristics.

Further validation of these interpretations would be necessary by taking other data collected and submitting them to these clusters to see if this classification holds true. Additional regression analysis might prove appropriate for this validation procedure. Also, it might prove necessary to have subjects rate these faces for each of the dimensions identified and use such measures as part of an overall replication procedure.

The previously described MDS was analyzed with considerations of the HCA to see if interpretations could be overlapping. Each procedure was sensitive to different characteristics of faces. The MDS seemed to be most sensitive to more global aspects of faces; whereas the HCA picked up on the individual local aspects of a face. Taken together, these analyses indicate that subjects do not consistently develop familiarity evenly across all faces, but rather attend to certain aspects of faces that are used for recognition. Perhaps such aspects may be specific to piecemeal or configurational factors, but they both represent a skewness in terms of individual differences contributing to developing familiarity.

DISCUSSION

The absence of a visual field effect on type S trials during blocks 1-4 (trials 1-144) of the present experiment was unexpected in light of the emergence of a relative strong LVF advantage during trials 73-144 of a similar experiment utilizing identical procedures, see Katsuyama, McNeese, and Schertler (1987). However, in this study stimuli are drawn from a pool of 24, rather than 48 faces. Thus, the difference appears to be attributable to the reduction in the stimulus set size. That is, the processing of faces across maximal perspective change seems to proceed without shifts in strategy that was proposed as accounting for changing lateral asymmetries obtained in the Katsuyama, McNeese, and Schertler (1987) study. Perhaps with the use of only 12 male and 12 female models, some subjects develop familiarity very rapidly Hence, the initial RVF advantage and emerging RVF advantage and emerging LVF advantage obtained in the previous study might not have occurred because of individual differences in the onset of strategy changes.

As in the aforementioned study, a LVF advantage emerged in the recognition of type 3/4 choices during trials 73-144. Subsequently, this LVF advantage tended to be replaced with a RVF advantage during trials 145-288 among subjects in Condition 1 (who received exposures to the same set of stimuli). The contrasting finding that no such reversal occurred among subjects in Condition 2 (who received exposure to the novel set of stimuli for trials 145-288) suggests that different strategies might have been in operation according to the relative familiarity of the stimuli.

Indeed, the results of the MDS and HCA suggest that not only are there individual differences in strategies of the subjects, but there are individual differences in the facial stimuli used that can contribute to differential "pick-up" of information across each face. If each face contains relatively different degrees of saliency which effect familiarity development, then the strategy utilized by a subject may act to vacillate visual field effects back and forth when various degrees of familiarity emerge during experimental conditions. The results in these series of studies tend to show a variety of shifts that occur. Interpretations over and beyond those already discussed may strongly relate to the insidious nature of familiarity based on the differential salience of faces. This suggests that studies must attend much more assiduously to the nature of the facial stimuli used, especially when real photographs of models are used. Future construction of stimuli might look at the set in terms of the dimensions derived and categorize stimuli accordingly so as to try to make familiarity more consistent. Consistency becomes a serious problem when individual strategies interact with individual differences of the stimulus set, especially when the same models are used to compose both the stimulus and response sets. The underlying nature of confusions likely rests with the underlying nature of familiarity and the degree of distinction created when faces are randomly selected from a stimulus pool.

In conclusion, it appears that lateral asymmetry is not contingent upon the nature of the stimulus initially encoded. Rather, both the prior experience with the stimulus item, the distinctiveness of this item in terms of the saliency of characteristics, and the required cognitive processing following initial exposure act to determine the type of strategies and, consequently, the nature of lateral asymmetry obtained.

APPENDIX A

Overall Confusion Matrix
(collapsed and summarized across 10 Ss individual matrices)

Row or Column Number represents face used as stimulus or choice item

	1	2	3	4	5	6	7	8	9	10	11	12
1	000											
2	.483											
3	.200	.300										
4	.200	.250	.300									
5	.633	.167	.350	.200								
6	.433	.800	.367	.700	.640							
7	.600	.411	.367	.367	.450	.000						
8	.750	.300	.300	.343	.500	.233	.275					
9	.375	.233	.625	.433	.367	.100	.140	.450				
10	.350	.460	.300	.200	.600	.400	.400	.150	.300			
11	.662	.467	.350	.200	.200	.380	.350	.400	1.000	.375		
12	.200	.250	.350	.400	.150	.367	.367	.000	.750	.320	.750	000
avg	*.443*	*.358*	*.368*	*.355*	*.415*	*.247*	*.306*	*.250*	*.683*	*.348*	*.750*	

avg. matrix value = .411

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